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FILING DATE: *March 26, 2003*
RELATED PCT APPLICATION NUMBER: *PCT/US04/09442*

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

JC857 U.S. PTO 60/458086

Express Mail Label No. EV281927019US

INVENTOR(S)

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☐ Additional inventors are being named on the _______ separately numbered sheets attached hereto

TITLE OF THE INVENTION (500 characters max)

ENERGY STORED IN SPRING WITH CONTROLLED RELEASE

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ENCLOSED APPLICATION PARTS (check all that apply)

☑ Specification Number of Pages: 8
☑ Drawing(s) Number of Sheets: 4
☐ Application Data Sheet. See 37 CFR 1.76
☐ CD(s), Number
☑ Other (specify): Check in the amount of $160.00 postcard receipt

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.
☑ A check or money order is enclosed to cover the filing fees
☑ The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 50-2140
☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($): $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
☑ No.
☐ Yes, the name of the U.S. Government agency and the Government contract number are: ______

Respectfully submitted,

SIGNATURE Russell R. Kassner

Date 03/26/2003

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Docket Number: 11672 (203-3617)

CERTIFICATION UNDER 37 C.F.R. § 1.10

I hereby certify that this correspondence and the documents referred to as enclosed are being deposited with the United States Postal Service on date below in an envelope as "Express Mail Post Office to Addressee" Mail Label Number EV281927019US addressed to: Assistant Commissioner for Patents, Box Provisional Patent Application,Washington, D.C. 20231.

Dated: March 26, 2003

Russell R. Kassner
Russell R. Kassner

PROVISIONAL PATENT APPLICATION
Atty. Docket: 11672 (203-3617)

ENERGY STORED IN SPRING WITH CONTROLLED RELEASE

BACKGROUND

In certain devices, such as surgical instruments, it is desirable to store energy within the instrument to facilitate firing the instrument. One such device is a clip applier disclosed in U.S. Patent No. 4,611,595. This clip applier stores energy in a spring which is retained by a latch mechanism. Movement of a handle disengages the latch resulting in rapid release of the stored energy to actuate the clip applier. However, in some instruments it would be desirable to have structure for allowing for a controlled release of the stored energy to control the rate of actuation of the instrument.

SUMMARY

Many surgical instruments, such as 60mm staplers in thick tissue, require more energy than can be comfortably developed by a single squeeze of a human hand. Currently, surgeons may use two hands to fire, or use instruments which require multiple, lower effort squeezes, to fire. In the present disclosure, the instrument is pre-energized by pumping at least once and possibly several times to store potential energy in a spring. This pre-energizing may be done by a surgical nurse or other assistant. This is particularly important during long procedures where fatigue, from multiple firings, may be uncomfortable to the surgeon. When the surgeon fires the instrument, the energy is released under the control of the surgeon.

DESCRIPTION OF THE DRAWINGS

Various embodiments are disclosed herein with reference to the drawings wherein:

FIG. 1 is a schematic view of an energy storage system, in an actuator handle, employing a hydraulic dampening structure;

FIG. 2 is a schematic view of an energy storage system, in a handle mechanism, employing a brake dampening system;

FIG. 3 is a schematic view of an energy storage system, in a handle mechanism, employing a second embodiment of a brake dampening system; and

FIG. 4 is a schematic view of an energy storage system, in a handle mechanism, employing a flywheel dampening system.

DETAILED DESCRIPTION

Energy is stored in a spring from one or more manual input actions, until a latching means is engaged. When the surgeon actuates the trigger, the latching means is disengaged, allowing the stored energy in the spring to be delivered into the working mechanism, and the instrument will begin to perform the desired function.

A damping means is incorporated into the system, to control the rate of energy release to a smooth, deliberate action. The damping may be hydraulic, pneumatic, mechanical or other suitable means. If desired, the release may be made controllable by the surgeon through the use of a valve, brake, flywheel or other

suitable control means, so as to allow him or her to go faster, slower, or even pause the release action.

It is further envisioned that the input action may be motor driven, such that energy may commence being transferred into the spring during the period of time when the disposable loading unit is being replaced, or even earlier, as right after the previous firing. Because the time period of transfer of energy from the motor to the spring is extended, a smaller, lighter motor and battery (or power supply) may be used.

Referring to FIG. 1, a handle actuator is disclosed for actuating various end effectors. The handle actuator generally includes a handle body and a drive rod movable therein to actuate the end effector. An energy storage system is provided to store energy and provide it to the drive rod upon release. The energy storage system includes a cylinder having a compressible die spring mounted therein. The die spring is positioned between a bottom cap of the cylinder and a piston slidably mounted in the cylinder. A pump handle is mounted at pivot point A to the housing. A piston rod extends through the cylinder and is affixed to the piston. A lower end of the piston is pivotally mounted to the pump handle at pivot point B. An upper end of the piston rod is connected to an L-rack having L-teeth. Large and small gear wheels are affixed to each other and are rotatably mounted to the housing. Teeth on the small gear wheel engage L-teeth on the L-rack while teeth on the large gear wheel engage drive teeth on the drive rod.

By rotating pump handle down about pivot A, piston rod is pulled down compressing the spring between the piston and the bottom cap. Various

[redacted]

embodiments are disclosed to restrain the compressed spring and allow controlled release of the energy stored in the spring. Pulling piston rod down pulls L-rack down causing L-teeth to rotate large and small gears counter clockwise by engagement with teeth on small gear. As large gear rotates counter clockwise, its teeth draw drive rod proximally by engagement with drive teeth. At this point, release of the spring reverses the action forcing drive rod distally to drive the end effectors.

As noted above, various embodiments of structure to restrain the compressed spring and allow for controlled release of the energy stored therein. With continued reference to FIG. 1, a hydraulic system is provided to control the release of the spring and provide greater control of the actuation of the instrument end effectors. The cylinder is sealed by top and bottom caps and is provided with an incompressible hydraulic fluid on either side of the piston. Preferably the piston is provided with an 0-ring to isolate the fluid on either side of the piston and allow smooth movement of the piston within the cylinder. A transfer system is provided between upper and lower ports in the top and bottom caps to move the hydraulic fluid from one side of the piston to the other within the cylinder as the spring is compressed. Upper and lower tubes are in fluid communication with the upper and lower ports. Movement of the piston within the cylinder forces the hydraulic fluid from one side of the piston to the other via the upper and lower tubes.

An actuation system for controlling the release of the spring generally includes a valve positioned between upper and lower tubes and a valve trigger to actuate the valve. Depression of the valve trigger progressively opens the valve to allow for flow of the hydraulic fluid. When the valve trigger is not depressed the valve is closed

and no fluid can flow therethrough. In order to allow for movement of this fluid from one side of the piston to the other during compression of the spring there is provided a bypass having a one way check valve positioned around the valve and between the upper and lower tubes. The one way check valve acts as a latch or restraining mechanism will only allow for flow of the fluid in the direction from the lower tube to the upper tube during compression of the spring.

In operation, pump handle is actuated to compress the spring and draw drive rod proximally as described hereinabove. The valve is closed and the check valve allows fluid to flow from lower tube to upper tube. Once the spring is fully compressed, the pressure of the fluid in the upper chamber of the cylinder maintains the spring in compression. Fluid cannot flow back through the bypass and one way check valve and the valve is closed. To controllably release the spring pressure and thus actuate the instrument, valve trigger is depressed to allow fluid to flow from upper tube to lower tube and lessen the fluid pressure in the upper chamber as the fluid is transferred to the lower chamber. The release of pressure and thus actuation of the instrument can be precisely controlled by the operator. By manipulating the valve trigger actuation can be instant and rapid, slow and progressive or even intermittent by repeated small depression of the valve trigger.

A further function of the hydraulic system is to dampen the movement of the piston within the cylinder to provide a smooth and controllable release of the spring pressure and actuation of the instrument.

Referring now to FIG. 2, there is disclosed a brake system to controllably release the spring pressure. It should be noted that all elements of the various

[redacted]

systems disclosed herein are identical to the first embodiment with the exception of the actuator control system. In FIG. 2, air fills the cylinder and upper and lower clearances around the piston rod allowing air to flow in and out of the cylinder. In order to restrain the spring in the compressed state and allow for controlled release of the spring pressure and thus actuation of the instrument there is provided a brake system which frictionally acts on the large and small gear assembly. The brake system includes a brake shoe which frictionally engages the large/small gear assembly. A bias spring as provided to bias the brake shoe into engagement with the large and small gear assembly with sufficient force to prevent rotation of the gear assembly and release of the spring pressure.

A trigger is pivotally mounted to the housing at pivot C and connected to the brake shoe by a transfer bar. Depression of the trigger moves the brake shoe progressively out of engagement with the gear assembly and against the bias of the bias spring. This allows controlled release of the spring pressure and thus actuation of the instrument.

Referring now to FIG. 3, there is disclosed an alternate embodiment of a brake assembly for controlled release of the spring and actuator of the instrument. A brake is provided to pivotally engage the gear assembly. A trigger is pivotally mounted to the housing at a fixed point. A first end extends out of the housing and a second end is connected to the brake by a linkage. A biasing spring acts on the second end to bias the brake into engagement with the large gear wheel.

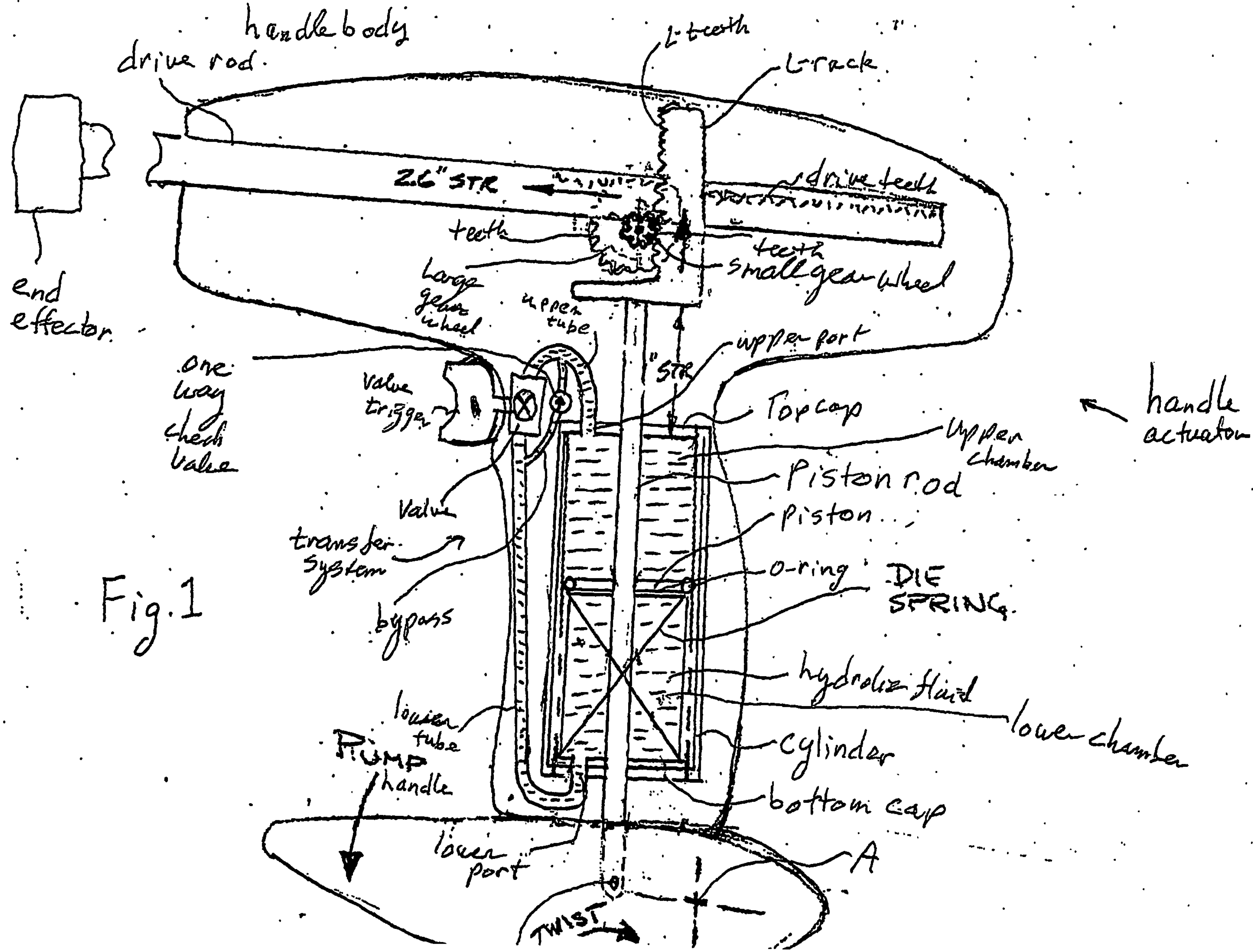
In a manner similar to that in FIG. 2, depression of the trigger lifts the brake away from the large gear wheel to controllably release the stored energy in the spring and controllably actuate the instrument.

Referring now to FIG. 4 there is disclosed a flywheel mechanism for controlled release of the energy stored in the spring and actuation of the instrument. A relatively large diameter flywheel is rotatably mounted in the housing and connected to the large gear wheel by a small diameter idler gear. The difference in diameters provides a mechanical advantage which reduces the pressure on the trigger needed to actuate the instrument. A trigger is pivotally mounted to the housing and includes a locking rack having teeth engageable with teeth on the flywheel and a cam surface also engageable with the flywheel. A trigger spring biases the trigger such that teeth on the locking rack firmly engage teeth on the flywheel to restrain the compressed spring.

Actuation of the trigger against the bias of the spring moves the teeth on the locking rack out of engagement with the flywheel and brings the cam surface into fractioned engagement with the flywheel. This allows for controlled release of the energy stored in the spring and controlled actuation of the surgical instrument. Importantly, the inertia present in the flywheel helps to smoothly control its rotation and thus actuation of the instrument. This retarded acceleration of the release of the spring pressure allows for smoother and slower actuation of the drive rod.

While several embodiments of the disclosure have been shown in the drawings, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be

read likewise. Therefore, the above description should not be construed as limiting, but merely as exemplifications of preferred embodiments. Those skilled in the art will envision other modifications within the scope of this disclosure.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teeth
teeth
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Large gear wheel
upper tube
upper port
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one way check valve
Valve trigger
Valve
transfer system
bypass
Top cap
upper chamber
Piston rod
Piston
o-ring
DIE SPRING
hydrolic fluid
lower chamber
cylinder
bottom cap
lower tube
PUMP handle
lower port
A
TWIST
handle actuator

Fig. 1

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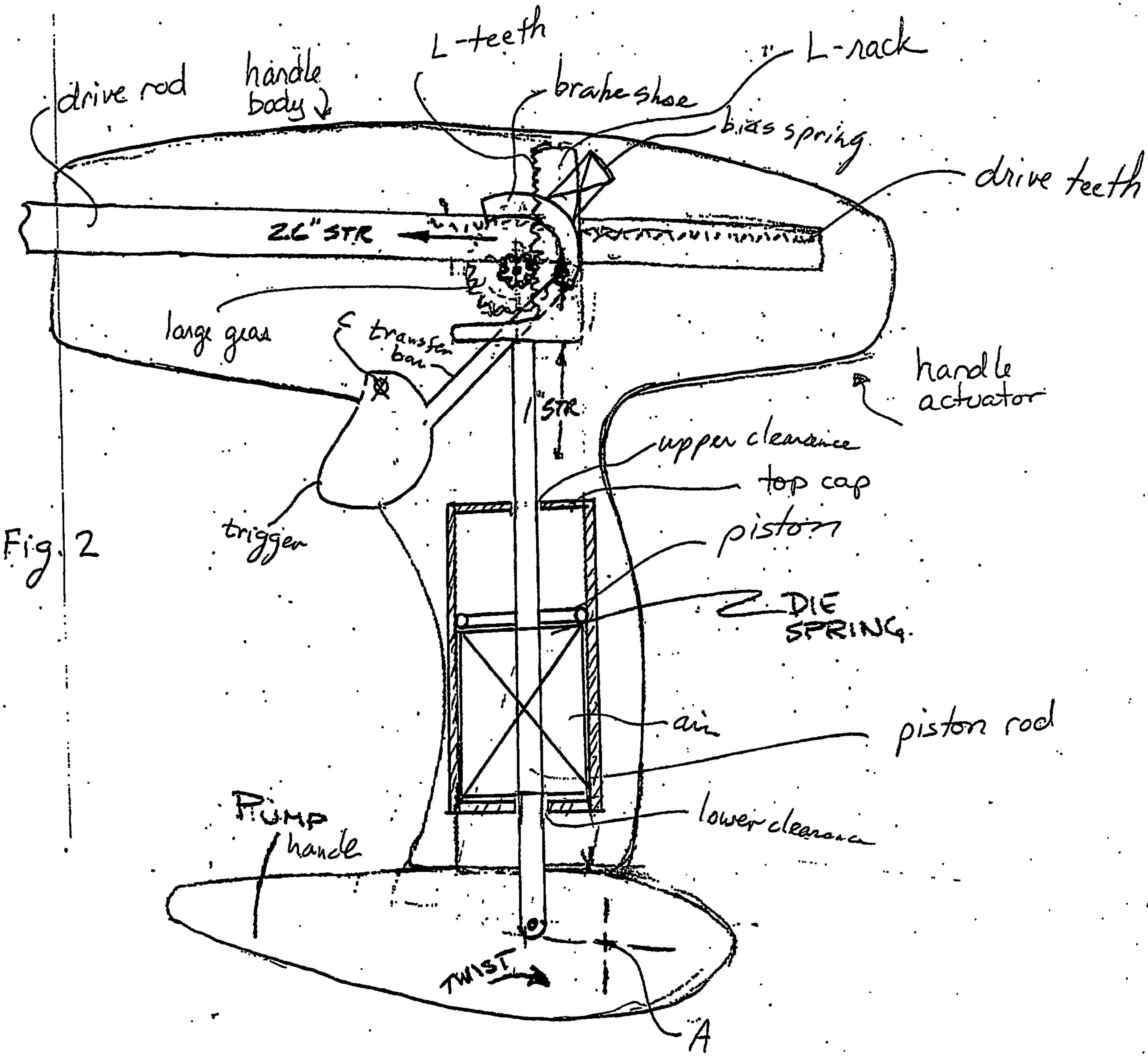
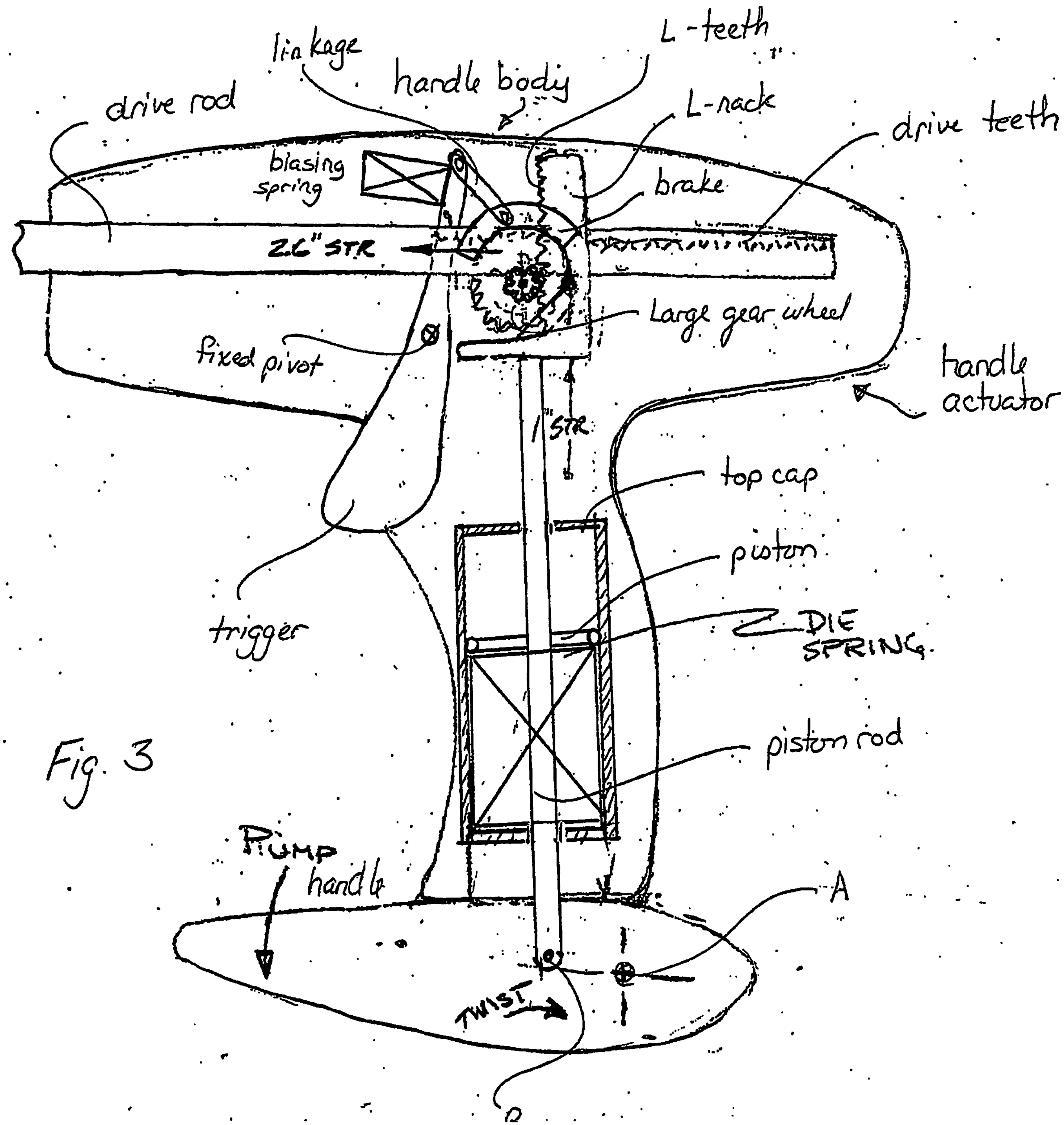


Fig. 2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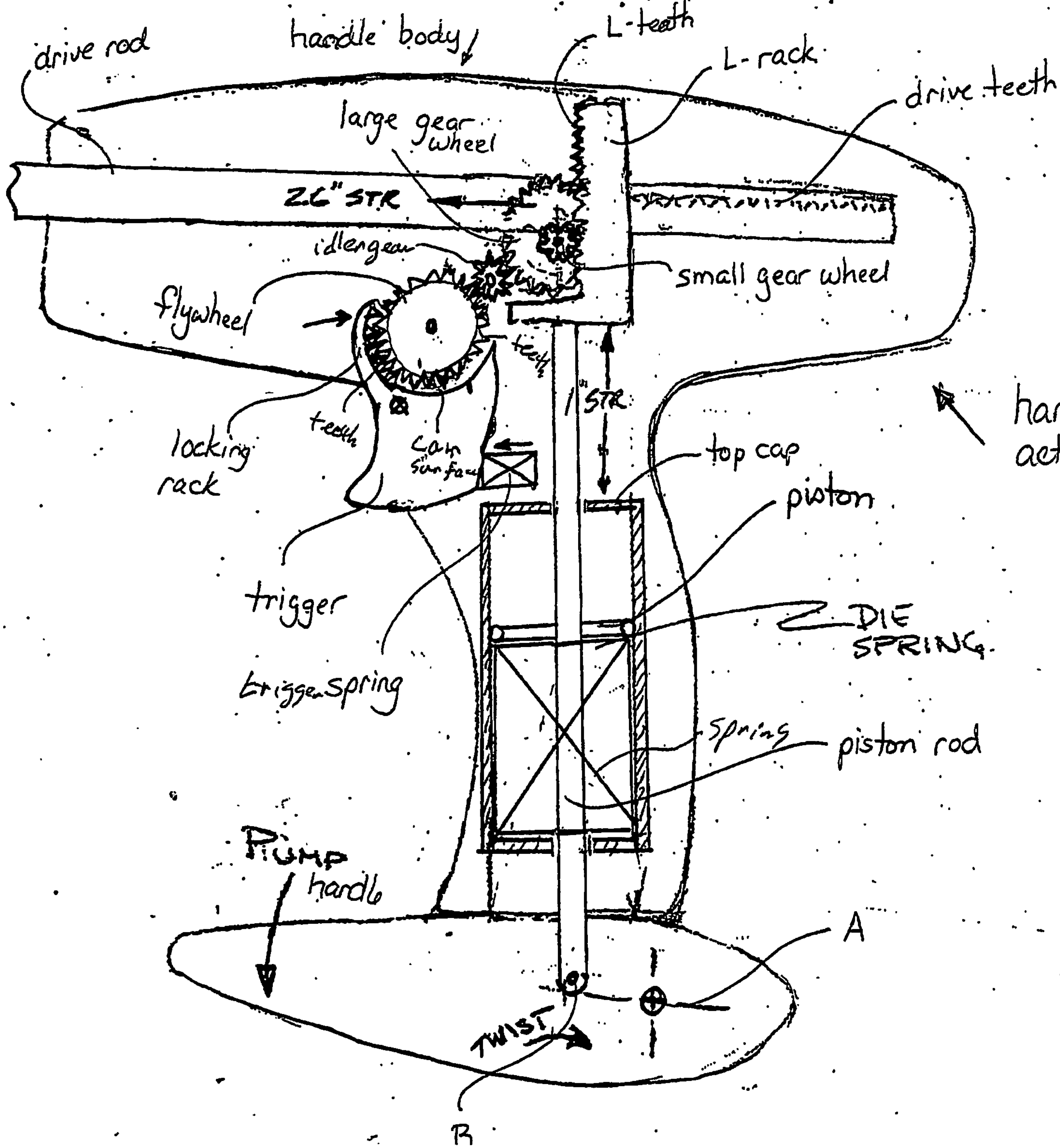
linkage
handle body
L-teeth
L-rack
drive teeth
blasing spring
brake
26" STR
Large gear wheel
fixed pivot
handle actuator
1" STR
top cap
piston
trigger
DIE SPRING
piston rod
PUMP handle
A
TWIST

Fig. 3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L-teeth
L-rack
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large gear wheel
2.6" STR
idlergear
small gear wheel
flywheel
teeth
1" STR
locking rack
teeth
cam surface
handle actuator
top cap
piston
trigger
DIE SPRING
trigger spring
Spring
piston rod
PUMP handle
A
TWIST
R

Fig. 4